Massachusetts Department of Public Health

2011
Massachusetts Arbovirus Surveillance and Response Plan

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Executive Summary

The 2011 MDPH Massachusetts Arbovirus Surveillance and Response plan provides surveillance and phased response guidance for both West Nile virus (WNV) and eastern equine encephalitis virus (EEE). In the past six years there have been sixteen cases of WNV infection reported in Massachusetts and fourteen human cases of EEE resulting in seven deaths. This plan reflects a comprehensive review of surveillance activities, mosquito control efforts, public information and risk communication related to arbovirus control in Massachusetts.

The purpose of the plan is to provide guidance on operational aspects of surveillance and response by state and local agencies responsible for the prevention of mosquito-borne disease in the 2011 season. The Department of Public Health will continue to seek advice from its partners and collaborators and modify the plan, as appropriate. This document is open to continual review and evaluation. Information is provided to guide planning and actions to reduce the risk of human disease from EEE and WNV.

Key objectives contained in this plan provide for:

- Monitoring of trends in EEE and WNV activity in Massachusetts;
- timely collection and dissemination of information on the distribution and intensity of WNV and EEE in the environment;
- laboratory diagnosis of WNV and EEE cases in humans, horses and other animals;
- effective communication, advice and support of activities that may reduce risk of infection;
- phased response to provide measures to suppress the risk of infection.

This document provides information about EEE and WNV disease and program goals, and specific guidelines for mosquito, equine and human surveillance. Additionally, this document provides guidance for the dissemination of information, including routine information; media advisories of positive EEE and WNV findings in mosquitoes, as well as public health alerts related to positive EEE and WNV human cases.

This plan describes MDPH's public outreach efforts to provide helpful and accurate communication with Massachusetts' residents about their risk from arboviral diseases and specific actions that individuals and communities can take to reduce this risk.

I. INTRODUCTION

The Massachusetts Department of Public Health (MDPH), in collaboration with the State Reclamation Mosquito and Control Board (SRMCB) and regional mosquito control projects (MCP's), conducts surveillance for mosquito-borne viruses that pose a risk to human health. The Massachusetts Arbovirus Surveillance Program (MASP):

- tests mosquitoes, specimens from appropriate suspect animals and from humans for evidence of infection;
- identifies areas of disease risk;
- provides information to guide decision-making to reduce the risk of disease; and
- informs the public of where and when there is an increased risk of infection.

The MASP currently focuses on West Nile (WNV) and eastern equine encephalitis (EEE) viruses, which are found in the local environment and are capable of causing serious illness and death in humans, horses and other mammals.

The 2011 Massachusetts Surveillance and Response Plan for mosquito-borne diseases is based on a comprehensive plan initially developed for WNV in 2001 in collaboration with local health agencies, other state agencies, academic institutions, the Centers for Disease Control and Prevention (CDC), and interested groups and individuals. It incorporates components of the state's EEE surveillance activities, which began in the 1950's and have continued since that time. The MASP began monitoring for WNV following a 1999 outbreak of human WNV disease in the New York City area, the first known occurrence of this disease in North America. WNV was identified in birds and mosquitoes in Massachusetts during the summer of 2000 and has been found during each consecutive season.

The updated 2011 plan is the result of analyses of surveillance data collected in Massachusetts and the United States. In addition, in order to manage the complexity of the human disease risk posed by these viruses, MDPH convened four workgroups that advised MDPH and promoted collaborative efforts by multiple agencies and interest groups. The purpose of the plan is to provide guidance on operational aspects of surveillance and response by the state and local agencies with responsibilities for the prevention of mosquito-borne disease. MDPH will continue to seek advice from its partners and collaborators and modify the plan, as appropriate. This document is open to continual review and evaluation with changes made when there is opportunity for improvement.

II. DISEASE HISTORY AND BACKGROUND

The two principal mosquito-borne viruses (also known as arboviruses, for **ar**thropod-**bo**rne viruses) recognized in Massachusetts and known to cause human and animal disease are eastern equine encephalitis virus with the first human cases identified in both the United States and Massachusetts in 1938, and West Nile virus, with the first human case identified in the United States in 1999, and in Massachusetts in 2001.

A. Eastern Equine Encephalitis Virus

1. Background

Eastern equine encephalitis is a serious disease, with 30-50% mortality and lifelong neurological disability among many survivors, which occurs sporadically in Massachusetts. The first symptoms of EEE are fever (often 103º to106ºF), stiff neck, headache, and lack of energy. These symptoms show up three to ten days after a bite from an infected mosquito. Inflammation and swelling of the brain, called encephalitis, is the most dangerous and frequent serious complication. The disease gets worse quickly and some patients may go into a coma within a week. There is no treatment for EEE. In Massachusetts, approximately half of the people identified with EEE have died from the infection. People who survive this disease will often be permanently disabled. Few people recover completely.

Historically, clusters of human cases have occurred in cycles lasting 2-3 years, with a hiatus of 10-20 years between outbreaks. In the years between outbreaks, isolated cases may occur. Outbreaks of human EEE disease in Massachusetts occurred in 1938-39 (35 cases, 25 deaths), 1955-56 (16 cases, 9 deaths), 1972-74 (6 cases, 4 deaths), 1982-84 (10 cases, 3 deaths), 1990-92 (4 cases, 1 death), 2004-06 (13 cases, 6 deaths). One human case of EEE occurred in 2010.

Massachusetts Eastern Equine Encephalitis Experience		
Year(s)	Human EEE Cases	Human EEE Deaths
1938-39	35	25
1955-56	16	9
1972-74	6	4
1982-84	10	3
1990-92	4	1
2004-06	13	6
2010	1	0

The Massachusetts Department of Public Health, with CDC funding, initiated a field surveillance program in 1957; following a 1955-56 outbreak of EEE. The purpose of the program was to gather data to guide prevention and risk reduction of this disease.

2. Risk Factors for Disease Transmission

Eastern equine encephalitis virus is an enzootic alphavirus found in some passerine bird species living in fresh-water swamp habitats. The virus is transmitted among wild birds in these areas primarily by *Culiseta melanura*, and secondarily by *Cs. morsitans* in other regions, both are mosquito species that feed predominantly on birds. This mosquito-borne virus has a cycle of natural infection among bird populations with occasional ‘‘incidental” symptomatic infections in susceptible species including humans, horses, llamas, alpacas, emus and ostriches. The prevalence of infection among birds is related to the prevalence in bird-feeding mosquitoes. When infections become more prevalent among birds, infection rates may also rise in mosquitoes that feed on both birds and other animals. Thus, infection within these bridge vector mosquitoes seems to enhance the risk of infection to people.

Outbreaks involving two or more human infections associated temporally and spatially may occur with the convergence of several factors. One major factor that affects the risk of disease in humans is the prevalence of immunity to EEE in the birds that serve as the enzootic reservoir of the virus. EEE infection in passerine birds usually results in a mild infection. Following infection, birds become immune to the virus and will not harbor it. Following a year of increased viral transmission, the prevalence of EEE immunity in birds increases and in subsequent years, the virus may not be able to spread rapidly among these reservoir hosts due to the establishment of ‘herd immunity’. Thus, elevated levels of herd immunity in birds may reduce the amplification of EEE in the bird-mosquito-bird cycle, which in turn reduces the chance of incidental infections in humans. When herd immunity is low and there are many susceptible birds; EEE infections can spread more rapidly and more widely among the birds.

A second major factor affecting the risk of human disease is the abundance of the enzootic vector. Certain mosquito species are highly selective as to the kind of host they will seek and feed upon. *Culiseta melanura* (*Cs. melanura*) mosquitoes feed primarily on birds and are recognized as the predominant vector of EEE transmission between passerine birds which are the reservoir of the virus. Thus, the intensity of enzootic EEE transmission correlates with the abundance of this enzootic vector. Abundant populations of this species provide greater opportunity for the virus to perpetuate or amplify within the bird population.

While each factor can individually affect human risk, the greatest risk for human disease occurs in seasons when there is both a lower proportion of immunity within the passerine bird populations and the mosquito vector population is abundant. The combination of these two factors should permit the greatest extent of viral amplification within the environment. This condition may enhance the potential for transfer of EEE to humans by a ‘bridge vector’ mosquito, i.e., species such as *Coquillettidia perturbans, Ochlerotatus canadensis, Aedes vexans and Culex species* that are less discriminate and will feed on birds or humans.

The risk of EEE infection in humans varies by geographical area in Massachusetts, as well as in the United States. EEE is more prevalent in areas that support dense populations of passerine birds and have favorable breeding conditions for the enzootic vector. In Massachusetts, these areas consist mainly of large wetlands containing mature white cedar and red maple swamps that are more common in southeastern and northeastern Massachusetts. The majority of EEE cases have occurred in Norfolk, Bristol, and Plymouth counties with some cases also occurring in Middlesex County, increasingly in Essex County and very rarely in Worcester County or further west. Historically, Cape Cod and the Islands of Martha’s Vineyard and Nantucket have not had human cases of EEE.
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Other major factors that affect the risk of EEE infections for humans are the abundance of specific kinds of mosquitoes at critical periods of the transmission season, groundwater levels and the timing of rainfall and flooding during the mosquito season. Participation in outdoor activities increases the risk of exposure while the use of personal protective measures (e.g., avoidance of mosquitoes, use of repellent) helps to reduce the risk of exposure.

Long-term weather patterns during the fall and winter that produce high ground water levels and snow cover may enhance survival of *Cs. melanura* larval populations. The abundance of these larval populations may serve as an early indicator of the potential for human disease later in the year. Multiple factors affect the development, survival, and abundance of mosquitoes. It is not currently possible to predict either the abundance of mosquitoes or the risks of encountering an infected vector later in the season. The best control approach to reduce these vectors must consider multiple factors. One approach calls for beginning integrated pest management (IPM) control activities early in the season and targeting both the enzootic and human biting vector species.

B. West Nile Virus

1. Background

West Nile virus (WNV) first appeared in the United States in 1999. Since an initial outbreak of infection in New York City, the virus has spread across the US from East to West. WNV infection may be asymptomatic in some people, but it leads to morbidity and mortality in others. WNV causes sporadic disease of humans, and occasionally results in significant outbreaks. Nationally, close to 1000 human cases of WNV neuroinvasive disease (West Nile meningitis and West Nile encephalitis) and WNV fever were reported to the CDC in 2010.

The majority of people who are infected with WNV (approximately 80%) will have no symptoms. A smaller proportion of people who become infected (~ 20%) will have symptoms such as fever, headache, body aches, nausea, vomiting, and sometimes swollen lymph glands. They may also develop a skin rash on the chest, stomach and back. Less than 1% of people infected with WNV will develop severe illness, including encephalitis or meningitis. The symptoms of severe illness can include high fever, headache, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, vision loss, numbness and paralysis. Persons older than 50 years of age have a higher risk of developing severe illness. In Massachusetts, there were six fatal WNV human cases identified between 2001-2010, all in individuals eighty years of age or older.

Following the identification of WNV in birds and mosquitoes in Massachusetts during the summer of 2000, MDPH arranged meetings between local, state and federal officials, academicians and the public to develop recommendations to improve and strengthen key aspects of the state plan for mosquito-borne virus surveillance and prevention of mosquito-borne disease. Four workgroups addressed the issues of surveillance, risk reduction interventions, pesticide toxicity and communication.

2. Risk Factors for Disease Transmission

West Nile (WN) virus is amplified by a cycle of continuous transmission between mosquito vectors and bird reservoir hosts. Infectious mosquitoes carry virus particles and infect susceptible bird species. WNV infection is often fatal in some species of birds, particularly American crows and blue jays (corvids). Confirmation of WNV in dead birds historically provided sentinel information used for assessing the risk of human WNV infections.

The principal mosquito vectors for West Nile virus on the East Coast are members of the genus *Culex*. These species may be abundant in urban areas, breeding easily in artificial containers such as birdbaths, discarded tires, buckets, clogged gutters, catch basins and other standing water sources. *Culex pipiens* and *Culex restuans* feeds mainly on birds and occasionally on mammals. They will bite humans, typically from dusk into the late evening.

Cumulative high temperatures and lower precipitation rates are factors that have been associated with higher mosquito infection and human illness rates. Additionally, warmer winter temperature conditions may result in larger numbers of Culex species overwintering as adult, with resulting increases in early season Culex abundance.

Brackish and freshwater wetlands are the preferred habitat for *Culex salinarius* which feeds on birds, mammals, and amphibians and is well known for biting humans. *Ochlerotatus japonicus* may be involved in the transmission of both WNV and EEE.
Natural and artificial containers such as tires and rock pools are the preferred larval habitat of this mosquito. It feeds mainly on mammals and is a fierce human bite

Activity of the West Nile virus zoonotic cycle varies from year to year. When a large number of infected birds and a high rate of infected mosquitoes occur in a relatively small geographic area, the risk of transmission of virus to humans will increase. Surveillance evidence indicates that WNV is established in the United States and that virus activity is likely to occur annually.

A summary of current and historical surveillance information for EEE and WNV in Massachusetts is available through **www.mass.gov/dph/wnv**.

C. Other viruses

Although other arboviruses are not routinely screened for as part of the MASP, MDPH's Bureau of Laboratory Sciences (i.e, the state public health laboratory) is prepared to rapidly implement screening for other relevant viruses carried by mosquitoes that may impact human health. These agents include Dengue or Chikungunya viruses, for example. Decisions to implement surveillance for new viruses will be based on information pertaining to changes in unusual activity associated with clinical diagnostic testing, national reports of new or unusual activity and/or local environmental detection of mosquito vectors that support new viral agents as part of an ongoing risk assessment performed by MDPH and CDC's Arbovirus Surveillance Network.

III. PROGRAM GOALS

Timely and accurate information provided by the MDPH based on surveillance information can be used to provide an indication of the level of risk of human disease from WNV and EEE. Based on this surveillance information, plans and actions to reduce risk can be developed and implemented when needed.

- Test mosquitoes, horses, humans and other appropriate animals to identify EEE and WNV infections.
- Track trends in incidence and prevalence of EEE and WNV infections by geographic area.
- Estimate viral infection rates in mosquitoes.
- Stratify risk in geographic areas as a function of relative risk of human disease.
- Conduct surveillance for human and animal disease.
- Educate human and animal medical practitioners on the appropriate procedures for detecting and identifying infections and disease caused by mosquito-borne viruses.
- Recommend measures to reduce virus transmission and disease risk.
- Educate the public on mosquito-borne diseases and disease risk, and common-sense precautions to reduce the risk of infection.
- Participate in the national Arbovirus Surveillance Network.

IV. AGENCY ROLES

A. Massachusetts Department of Public Health (MDPH)

The central purpose of the MASP is to provide information that will guide planning and activities to reduce the risk of human disease from EEE and WNV infection. To achieve this, the main objectives are to monitor trends in EEE and WNV in Massachusetts; provide timely information on the distribution and intensity of WNV and EEE in the environment; perform laboratory diagnosis of WNV and EEE cases in humans, horses and other animals; communicate effectively with officials and the public; provide guidelines, advice and support on activities that effectively reduce risk of disease; and provide information on the safety, anticipated benefits and potential adverse effects of proposed prevention interventions.

MDPH works cooperatively with the SRMCB, regional mosquito control projects and other state agencies to collectively identify and support the use of safe and effective mosquito control measures based on integrated pest management (IPM) principles. The use of pesticides as a means to reduce human risk is one of several methods/strategies to attain this goal.

B. State Reclamation and Mosquito Control Board (SRMCB)

The SRMCB oversees mosquito control programs and activities in the Commonwealth of Massachusetts. The SRMCB consists of three (3) members representing the Department of Agricultural Resources (DAR), Department of Conservation and Recreation (DCR), and Department of Environmental Protection (DEP). Additionally, the SRMCB advises its respective state agency Commissioners on actions to reduce mosquito populations based on MDPH findings and characterization of risk.

The SRMCB 'Operational Response Plan to Reduce the Risk of Mosquito-Borne Disease in Massachusetts' addresses the issues related to the operational aspects of adult mosquito surveillance and control to prevent and/or reduce the risk of mosquito-borne diseases. The plan may be viewed via the web at www.mass.gov/agr/mosquito/arbovirus.htm.

In 2006, the SRMCB created a SRMCB Mosquito Advisory Group (MAG). The MAG provides independent scientific advice to the SRMCB to assist them in evaluating and assessing data from both DPH and mosquito control projects.

C. Mosquito Control Projects (MCP)

There are nine (9) organized mosquito control projects or districts located throughout Massachusetts. All of the mosquito control activities of these organized agencies are performed under the aegis of the SRMCB. Mosquito Control Projects collaborate with local boards of health in their jurisdictions to control mosquitoes. These locally authorized efforts employ a variety of targeted activities for source reduction, larviciding and adulticiding that are in compliance with the SRMCB Operational Response plan.

V. SURVEILLANCE

A. Mosquito Surveillance for West Nile Virus (WNV) and Eastern Equine Encephalitis (EEE) Virus

Surveillance of mosquitoes for arboviruses is one of the core functions of the MASP. Monitoring mosquitoes for the presence of virus provides a direct estimate of risk to humans. Massachusetts has a long-term field surveillance program that was initiated in 1957 for EEE and was modified in 2000 to include WNV surveillance. The extensive experience in Massachusetts with surveillance for mosquito-borne disease provides expertise and capacity to guide risk reduction efforts. The MASP uses a comprehensive and flexible strategy that modifies certain surveillance activities in response to trends in disease risk.

On an ongoing basis, MASP will continue to monitor national and regional surveillance data and current scientific literature to assess risk of newly emerging arboviruses in Massachusetts. In addition, defined subsets of mosquito pools will be evaluated by MDPH for the presence of new or emerging viruses

1. Fixed and Long-Term Trap Sites

MASP will collect mosquitoes from areas with activity during the previous year, and from long-term trap sites maintained in the EEE high-risk areas of southeastern and eastern Massachusetts (Figure 1). Trapping of gravid mosquitoes for testing of WNV is conducted both by mosquito control projects and MDPH staff at various locations throughout the state during the arbovirus season. At the William A. Hinton State Laboratory Institute (SLI), MDPH's Bureau of Laboratory Sciences' tests samples (pools of 10- 50 specimens) of trapped mosquito collections are tested for WNV and EEE. Test results from routine mosquito collections are available within 24 hours. Fixed and long-term trap sites provide the best available baseline information for detecting trends in mosquito abundance and virus prevalence and for estimating the relative risk of human infection from EEE and WNV. MDPH will monitor larvae from select sites in late fall and early spring to determine end-season and pre-season larval abundance. Informal monitoring of larval abundance from these sites continues on a weekly basis during the arbovirus season.

2. Supplemental Trap Sites

When EEE or WNV activity is detected in an area, additional trap sites and/or trap types will be used to obtain more information regarding the intensity of virus activity in mosquitoes. The following risk indicators may result in the implementation of more intensive mosquito trapping: 1) virus isolations in mosquitoes; 2) emergence of large numbers of human-biting mosquitoes in an area with a high rate of virus activity and 3) human or equine cases.

3. Mosquito Control Project Trap Sites

Massachusetts Mosquito Control Projects (MCP's), are organized under the State Reclamation and Mosquito Control Board (SRMCB), housed within the Department of Agricultural Resources. The SRMCB is composed of three members; representing the Department of Agricultural Resources; the Department of Environmental Protection; and the Department of Conservation and Recreation. MCP's and the SRMCB communicate collaboratively with the MASP. The mosquito control projects employ comprehensive integrated pest management (IPM) principles. The IPM program uses a variety of available control strategies to impact mosquito abundance. Monitoring mosquito abundance is accomplished through various surveillance methods including but not limited to larval dip counts and the use of light/ CO_2 baited traps and gravid traps. Additional details relating to control strategies may be found within the SRMCB Operational Plan.

B. Avian Surveillance: West Nile Virus (WNV) and Eastern Equine Encephalitis Virus (EEE)

MDPH MASP discontinued avian surveillance for WNV as of April, 2009. When it was first introduced into the United States, WNV caused high mortality rates in certain species of birds, particularly corvids, thus reporting and testing of dead birds was a productive way to detect and monitor WNV activity in an area. However, in recent years, the tracking and testing of dead birds has become significantly less useful as fewer birds are still susceptible to fatal WNV infections. Monitoring mosquitoes for presence of virus remains the primary predictive indicator of human arbovirus disease risk. Therefore, the routine laboratory testing of dead wild birds for West Nile virus (WNV) has been completely eliminated. This is consistent with recent policy changes in multiple states.

Most birds that are infected with EEE generally survive the viremia, making individual dead bird EEE monitoring impractical. Testing of highly suspect bird specimens for EEE infection will be done on an as-needed basis as determined by the MDPH State Public Health Veterinarian and the MASP. The MDPH State Pubic Health Veterinarian will determine whether or not it is appropriate to test specimens from dead bird clusters for either WNV or EEE infection.

The 24/7 information line (1-866-MassWNV) will be maintained. Callers will receive recorded messages that provide information on why birds are no longer tested; information on WNV/EEE disease; and instructions for proper disposal of dead birds. More detailed information on this topic is available on the MDPH website.

C. Animal Surveillance: West Nile Virus (WNV) and Eastern Equine Encephalitis Virus (EEE)

Specimens from horses and other domestic animals that have severe neurological disease suspected of being caused by EEE or WNV infection are tested at SLI. Confirmatory testing, when necessary, may take up to nine working days. Massachusetts' veterinarians, the state Department of Agricultural Resources, USDA and Tufts University School of Veterinary Medicine collaborate with the MASP to identify and report suspect animal cases. In addition, blood and/or tissue samples from animals from other sources, such as zoos or horse stables, or wild animals may be tested. Current information on WNV and EEE infections in horses along with clinical specimen submission procedures are disseminated to large animal veterinarians, stable owners, and other populations as needed, through mailings and postings on the MDPH Arbovirus website at **www.mass.gov/dph/wnv**. Many horses are immunized against infection with WNV and EEE with available veterinary vaccines. Vaccination is the primary means of preventing infection in animals.

D. Human Surveillance

1. Passive surveillance

Specimens from human cases of encephalitis and meningoencephalitis are submitted to MDPH and screened for human possible causes of infection, including WNV and EEE. Confirmatory testing, when necessary, may take three to seven working days. Current information on WNV and EEE infections in humans, along with clinical specimen submission procedures are disseminated to physicians (infectious disease, emergency medicine and primary care), emergency department directors and hospital infection control practitioners through mailings, broadcast faxes, and postings on the MDPH arbovirus website at **www.mass.gov/dph/wnv**.

2. Active surveillance

If surveillance data indicate a high risk of human disease, active surveillance may be instituted in targeted areas. Active surveillance involves regularly contacting local health care facilities to communicate current surveillance information, prevention strategies and specimen submission procedures. HHAN (Health and Homeland Alert Network) alerts are sent to local boards of health upon confirmation of EEE or WNV in any specimen; health care facilities are advised of increased risk status and the corresponding need to send specimens to SLI for testing.

3. Pesticide related surveillance

Outreach on pesticide illness reporting will be coordinated by the MDPH Bureau of Environmental Health. In the event of an aerial pesticide application, active surveillance efforts will be implemented with emergency departments and intensified outreach efforts will be made to health care providers.

VI. Communication of Surveillance Information

The MASP will provide information to guide planning and actions to reduce the risk of human disease from EEE and WNV. MDPH works with the SRMCB and MCPs to identify and support the use of risk reduction and disease prevention methods that are specific to the causes of disease; and supports planning and practices which incorporate the most appropriate prevention methods. Additionally, MDPH routinely communicates with health agencies in neighboring states to share relevant Arboviral findings.

Prior to the beginning of the arbovirus season, general disease information and specimen submission procedures will be provided to local boards of health via electronic messages from the Massachusetts Health and Homeland Alert Network (HHAN). General information and fact sheets are posted on the MDPH arbovirus website and available for MCP's, physicians, veterinarians, animal control officers, and other agencies.

Laboratory confirmation of a human WNV or EEE case is immediately reported by telephone to the submitting physician, and local board of health (LBOH) in the town where the case resides. If the LBOH cannot be reached via telephone in a timely manner, a severe level HHAN alert will be sent.

Laboratory confirmation of infection in a horse (or other veterinary specimen) with WNV or EEE infection will be immediately reported by telephone to the submitting veterinarian, the Department of Agricultural Resources- Division of Animal Health, Biosecurity and Dairy Services and the LBOH. As with human cases, if the LBOH cannot be reached in a timely manner, a severe level HHAN alert will be sent.

Initial positive findings in mosquitoes (WNV and EEE) from a given town will be reported to the LBOH and MCP's by telephone. Adjacent towns will be notified via a moderate level HHAN alert. In order to encourage risk communication on a focal area level rather than a city/town level, all subsequent positive findings in mosquitoes will be reported once daily to all affected towns and adjacent towns, via a moderate level HHAN alert. All subsequent positive mosquito findings will be reported once daily to all MCP's and the SRMCB.

The MDPH Regional Health Office in the area will offer assistance with local response. All laboratory confirmed results for WNV and EEE in humans, horses, other veterinary specimens, mosquitoes are provided to the regional health department representative, mosquito control projects and members of the SRMCB once the LBOH has been notified.

At the time of notification, MDPH will encourage LBOHs to share the information with other local agencies and high-risk populations in their community as appropriate. MDPH provides LBOH with sample press releases for their use. Depending on the circumstances, MDPH may also issue a public health alert. In addition, weekly summaries of results from mosquito samples submitted and tested will be posted as News Items on the HHAN by town.

After all appropriate individuals and agencies have been sent notification, positive surveillance findings are made available to the media and general public on the MDPH Arbovirus website at **www.mass.gov/dph/wnv**. This website, which also includes a variety of educational materials related to preventing mosquito-borne disease, is updated on a daily basis throughout the arbovirus season. Results are also reported to the Centers for Disease Control and Prevention's (CDC) ArboNET reporting system.

MDPH issues public health alerts through the media when surveillance information indicates an increased risk of human disease or if a significant surveillance event occurs (for example, the first arbovirus activity of the season). In general, alerts will include current surveillance information and emphasize prevention strategies. Alerts will be drafted in consultation with state and local agencies.

VII. Prevention and Response: Recommendations for Phased Response to Surveillance Data

The guidance provided here is based on current knowledge of risk and appropriateness of available interventions to reduce the risk for human disease. Multiple factors contribute to the risk of mosquito-transmitted human disease. Decisions on risk reduction measures should be made after consideration of all surveillance information for that area at that time.

Public awareness of what can be done to reduce risk of infection is of utmost importance. The level of EEE and WNV activity may occasionally present a potential for increased virus transmission to humans. Typically, risk for any individual is expected to be relatively low, and the routine precautions taken by individuals may be sufficient to reduce opportunities for infection. These guidelines take into consideration the complexity of reducing risk of human disease from EEE and WNV infection and form a framework for decision-making.

General guidelines are provided for an array of situations that are noted in the Surveillance and Response Plan tables that follow. Specific situations must be evaluated individually and options discussed before final decisions on specific actions are made. The assessment of risk from mosquito-borne disease is complex and many factors modify specific risk factors. MDPH assesses risk and works with local public health agencies, mosquito control projects, and the SRMCB to develop the most appropriate response activities to reduce the risk of human disease. There is no single indicator that can provide a precise measure of risk, and no single action that can assure prevention of infection.

When recommending the use of mosquito larvicides or adulticide, MDPH works collaboratively with other state agencies, the SRMCB and regional mosquito control projects to collectively identify and support the use of safe and effective mosquito control measures based on integrated pest management (IPM) principles.

A. MDPH Guidance

The MDPH Arbovirus Program will determine human risk levels as outlined in the phased response tables of this plan. Risk levels are defined for focal areas. “Focal Areas” may incorporate multiple communities, towns or cities. Factors considered in the determination of human risk in a focal area include: mosquito habitat, prior virus isolations, human population densities, timing of recent isolations of virus in mosquitoes, the cyclical nature of human outbreaks (EEE), current and predicted weather and seasonal conditions needed to present risk of human disease.

If the risk of an outbreak becomes widespread and involves multiple jurisdictions, MDPH will confer with local health agencies, SRMCB, MCP’s, and MAG to discuss the use of intensive mosquito control methods and determine whether measures need to be taken by the agencies to allow for and assure that the most appropriate mosquito control interventions are applied to reduce risk of human infection. These interventions may include state-funded aerial application of mosquito adulticide. Factors to be considered in making this decision include the cyclical, seasonal and biological conditions needed to present an ongoing high risk of WNV or EEE human disease.

Once significant human risk has been identified in a focal area by MDPH, MDPH will coordinate with the SRMCB to determine the adulticide activities that should be considered and implemented in response. The SRMCB will provide recommendations on appropriate pesticide(s), route and means of treatment for the specific treatment areas. Based on historical experience with EEE, MDPH has identified specific critical indicators for EEE, infection rates, and provides specific risk reduction and prevention guidance for seasons with an anticipated increased EEE risk.

B. Risk Reduction and Prevention Guidance for Seasons with Indicators of Increased EEE Risk

Activities that may be undertaken in response to indicators of increased risk include:

- MDPH may release public health alerts throughout the season to remind the public of the steps to take to reduce their risk of exposure to mosquitoes.
- MCP's may increase their source reduction activities to reduce mosquito-breeding habitats and to reduce adult mosquito abundance. This may include ground and aerial larviciding.
- After sustained findings of positive mosquito isolates, if not already in progress, adult mosquito control efforts including targeted ground adulticiding operations should be considered. The decision to use ground-based adult mosquito control will depend on critical modifying variables including the time of year, mosquito population abundance and proximity of virus activity to at-risk populations.
- Other intensified efforts may be implemented following coordination between MDPH and other agencies including DEP, MDAR, and DCR.

Aerial Adulticide Application in Response to Mosquito-Borne Disease Threat
2011 Multi-Agency Response Flowchart

1. Determination of Response

- When human risk is elevated to a high level of concern as indicated by the MDPH Surveillance and Response Plan; DPH/BID will determine, in consultation with Mosquito Control Projects, SRMCB and the Mosquito Advisory Group whether aerial application is warranted.

2. Characterization of Area of Risk

- Once consensus is obtained, DPH/BID characterizes the area of risk and delineates the perimeter of the spray area based on mosquito and virus surveillance.
- DPH/BID provides the GIS perimeter map to inter-agency collaborators as soon as possible.

3. Commissioner Certification

- DPH BID requests Commissioner of Public Health issue a "Certification that Pesticide Application is Necessary to Protect Public Health"

Action Items 4a-4c Occur Simultaneously:

4a. Determination of Appropriate Pesticide

- Prior to July 1 of each season, DPH/BEH and DAR will determine the type of pesticide to be used in the event that an aerial application will be warranted and obtain any EPA pesticide waivers, if necessary, for use in aerial application.
- In the event that aerial application is warranted, DPH/BEH and DAR will confirm this selected pesticide for use.

4b.Determination of No-Spray Zones

- No- aerial spray zones (mosquito treatment sensitive areas data layers) defined:
  1)Certified organic farms
  2)Priority habitats for spray sensitive state-listed rare species
  3)Surface water supply resource areas
  4)Commercial fish hatcheries/aquaculture
- DAR reviews any emergency waivers needed to use pesticides on school property and ensure compliance with pesticide laws.
- DAR/SRMCB will submit a 'Notice of Intent' to EPA to obtain an NPDES permit within 30 days of the aerial adulticide event.

4c.Exclusion/Inclusion of Priority Habitats:

- DPH/BID will determine, in consultation with SRMCB, DAR, DEP, and DFW if spraying in mosquito treatment sensitive areas is necessary to protect the public health.
- If spraying in these areas is necessary to reduce the risk to public health then:
  - DPH BID requests a permit from DFW be issued to DAR for taking endangered, threatened, or special concern species.

5. Preparation of Final GIS Data Map

- DAR coordinates compilation of mosquito treatment sensitive areas data layers (no-spray zones) developed by DAR, DFW, and DEP within designated DPH spray area into a final map.

6. Environmental Monitoring

- DEP, DAR, and DPH/BEH notify partner environmental agency collaborators of planned environmental monitoring to provide opportunity for input/collaboration.

DEP, DAR, and DPH/(BEH/SLI) initiate plans for pre/post-monitoring for public drinking water reservoirs, honey bees, macro-invertebrates, and cranberries in designated spray area.

7. Emergency Room and Poison Control Contacts

- DPH/BEH contacts and provides pesticide illness surveillance protocols to emergency departments, poison control centers, and local health departments.

8. Notification of Date & Time of Application

- DAR and DPH provide public notices regarding the locations, dates, and times of aerial spraying.
- DAR will maintain a website with GIS maps of the aerial spray area and will update this site daily during spray operations.
- DPH will provide recorded hotline information regarding the spray zone, precautionary measures, and telephone numbers to report fish kills or other environmental impacts.

9. Operational Procedures-Aerial Application

- DAR/SRMCB initiates aerial spray operations using collective guidance and consensus developed through multi-agency, cross secretariat process.
- The aerial application operational procedures are followed as described in the SRMCB Operational Response Plan.

DPH- Department of Public Health
BID- Bureau of Infectious Diseases
BEH- Bureau of Environmental Health
BLS- Bureau of Laboratory Sciences

DAR- Department of Agricultural Resources
SRMCB- State Reclamation and Mosquito Control Board
DFG-Department of Fish and Game
DFW- Division of Fisheries and Wildlife

Table 1. Guidelines for Phased Response to WNV Surveillance Data

Risk Category	Probability of human outbreak	Definition of Risk Category for a Focal Area[1]	Recommended Response
1	Remote	All of the following conditions must be met: Prior Year No prior year WNV activity detected in the focal area. And Current Year No current surveillance findings indicating WNV activity in mosquitoes in the focal area And No animal or human cases.	1. MDPH staff provides educational materials and clinical specimen submission protocols to targeted groups involved in arbovirus surveillance, including, but not limited to, local boards of health, physicians, veterinarians, animal control officers, and stable owners. 2. Educational efforts directed to the general public on personal prevention steps and source reduction, particularly to those populations at higher risk for severe disease (e.g., the elderly). 3. MDPH provides recorded information on WNV/EEE disease, and disposal of dead birds via MDPH WNV information line (1-866-MASS-WNV). 4. Assess mosquito populations, monitor larval and adult mosquito density. 5. Routine collection and testing of mosquitoes. 6. Initiate source reduction; use larvicides at specific sites identified by entomologic survey. In making a decision to use larvicide consider the abundance of *Culex* larvae, intensity of prior virus activity and weather. 7. Locally established, standard, adult mosquito control activities are implemented. No specific supplemental control efforts are recommended. 8. Passive human and horse surveillance. 9. Emphasize the need for schools to comply with MA requirements for filing outdoor IPM plans.

[1] Focal Area- May incorporate multiple communities, towns or cities. Factors considered in determination of human risk in a focal area include mosquito habitat, prior isolations, human population densities, timing of current isolations of virus in mosquitoes, the cyclical and seasonal conditions needed to present risk of human disease

2	Low	Prior Year Any WNV activity in mosquitoes in the community or focal area Or Current Year 1. Sporadic WNV activity in mosquitoes in the focal area. And 2. No animal or human cases Definitions: ***Sporadic*** WNV activity- when 1-2 mosquito isolates are detected during non-consecutive weeks within one focal area. ***Sustained*** WNV activity- when mosquito isolates are detected for 2 or more consecutive weeks within one focal area.	Response as in category 1, plus: 1. Expand community outreach and public education programs, particularly among high-risk populations, focused on risk potential and personal protection, emphasizing source reduction. 2. Increase larval control and source reduction measures. 3. Public health alert sent out by MDPH in response to first WNV virus positive mosquito pool detected during the season. The alert will summarize current surveillance information and emphasize personal prevention strategies. 4. Locally established standard adult mosquito control activities continue.
3	Moderate	Prior Year Confirmation of one or more human or animal WNV cases; or sustained WNV activity in mosquitoes for 2 or more weeks. Or Current year 1. Sustained WNV activity plus at least one multiple meteorological or ecological conditions (such as above average temperatures, dry conditions, or larval abundance) associated with increased abundance and increased risk of human disease. Or 2. A single WNV isolate from mosquitoes likely to bite humans such as *Oc.japonicus* or *Oc. Canadensis.* And 3. No animal or human WNV cases	Response as in category 2, plus: 1. Outreach and public health educational efforts are intensified including media alerts as needed. 2. If not already in progress, standard, locally established adult mosquito control efforts including targeted ground adulticiding operations should be considered against *Culex* mosquitoes and other potential vectors, as appropriate. The decision to use ground-based adult mosquito control will depend on critical modifying variables including the time of year, mosquito population abundance and proximity of virus activity to at-risk populations. 3. Duly authorized local officials may request that DPH Commissioner issue a certification that pesticide application is necessary to protect public health in order to preempt homeowner private property no-spray requests. 4. Supplemental mosquito trapping and testing may be performed in areas with positive WNV findings. 5. Local boards of health are contacted via phone or HHAN (Health and Homeland Alert Network) upon confirmation of WNV in any specimen. Advise health care facilities of increased risk status and corresponding needs to send specimens to SLI for testing.

4	High	<u>Current Year</u> 1. Sustained or increasing WNV activity in mosquitoes plus multiple meteorological or ecological conditions (such as above average temperatures, dry conditions, increased larval abundance) associated with elevated mosquito abundance; and increasing minimum infection rates. And/or 2. MDPH confirmation of WNV in an animal at any time And/ or, 3. MDPH confirmation of WNV in a human at any time	Response as in category 3, plus: 1. Intensify public education on personal protection measures including avoiding outdoor activity during peak mosquito hours, wearing appropriate clothing, using repellents and source reduction. a. Utilize multimedia messages including public health alerts from MDPH, press releases from local boards of health, local newspaper articles, cable channel interviews, etc. b. Encourage local boards of health to actively seek out high-risk populations in their communities (nursing homes, schools, etc.) and educate them on personal protection d. Advisory information on pesticides provided by MDPH Bureau of Environmental Health. e. Urge towns and schools to consider rescheduling outdoor events. 2. Intensify and expand active surveillance for human cases. 3. Intensify larviciding and/or adulticiding control measures where surveillance indicates human risk. Local, ground- based ULV applications of adulticide may be repeated as necessary to achieve adequate mosquito control. Town or city may request preemption of homeowner private property no-spray requests. 4. Local officials should evaluate all quantitative indicators including population density and time of year and may proceed with focal area aerial adulticiding. 5. Duly authorized local officials may request that the DPH Commissioner issue a certification that pesticide application is necessary to protect public health in order to preempt homeowner private property no-spray requests. 6. MDPH will confer with local health officials, SRMCB and Mosquito Control Projects to determine if the risk of disease transmission threatens to cause multiple human cases and warrants classification as level 5.

5	Critical	Current Year 1. More than 1 confirmed human case in a community or focal area Or 2 .More than 1 confirmed animal case in a community or focal area Or 3. Multiple quantitative measures indicating critical risk of human infection (e.g. early season positive surveillance indicators, and sustained elevated field mosquito infection rates, and horse or mammal cases indicating escalating epizootic activity)	Response as in category 4, plus: 1. Continued highly intensified public outreach messages on personal protective measures. Frequent media updates and intensified community level education an outreach efforts. 2. The MDPH Arbovirus Program will determine human risk levels as outlined in this plan. If risk of outbreak is widespread and covers multiple jurisdictions, MDPH will confer with local health agencies, SRMCB and Mosquito Control Projects to discuss the use of intensive mosquito control methods and determine if measures need to be taken by the agencies to allow for and assure that the most appropriate mosquito control interventions are applied to reduce risk of human infection. These interventions may include state-funded aerial application of mosquito adulticide. Factors to be considered in making this decision include the cyclical, seasonal and biological conditions needed to present a continuing high risk of WNV human disease. Once critical human risk has been identified, the SRMCB will determine the adulticide activities that should be implemented in response to identified risk by making recommendations on: A. Appropriate pesticide B. Extent, route and means of treatment C. Targeted treatment areas 3. MDPH Bureau of Environmental Health will initiate active surveillance via emergency departments and with health care provides only if aerial spraying commences. 4. MDPH will designate high-risk areas where it has issued a certification that pesticide application is necessary to protect public health in order to preempt homeowner private property no-spray requests. If this becomes necessary, notification will be given to the public. 5. MDPH recommends restriction of group outdoor activities, during peak mosquito activity hours, in areas of intensive virus activity. 6. MDPH will communicate with health care providers in the affected area regarding surveillance findings and encourage prompt sample submission from all clinically suspect cases.

Table 2. Guidelines for Phased Response to EEE Surveillance Data

Risk Category	Probability of human outbreak	Definition of Risk Category for a Focal Area[2]	Recommended Response
1	Remote	All of the following conditions must be met: <u>Prior Year</u> No EEE activity detected in a community or focal area And <u>Current Year</u> No current surveillance findings indicating EEE activity in mosquitoes in the focal area And No animal or human EEE cases.	1. MDPH staff provides educational materials and clinical specimen submission protocols to targeted groups involved in arbovirus surveillance, including, but not limited to, local boards of health, physicians, veterinarians, animal control officers, and stable owners. 2. Educational efforts directed to the general public on personal prevention steps and source reduction, particularly to those populations at higher risk for severe disease (e.g., the elderly). 3. Routine collection and testing of mosquitoes. 4. Assess mosquito populations, monitor larval and adult mosquito density. 5. Initiate source reduction; use larvicides at specific sites identified by entomologic survey and targeted at the likely amplifying bridge vector species. In making a decision to use larvicide consider the prevalence of Culiseta and bridge vector larvae, intensity of prior virus activity, and weather. 6. Locally established, standard, adult mosquito control activities are implemented. No specific supplemental control efforts are recommended. 7. Passive human and horse surveillance. 8. Emphasize the need for schools to comply with MA requirements for filing outdoor IPM plans.

[2] Focal Area- May incorporate multiple communities, towns or cities. Factors considered in the determination of human risk in a focal area include: mosquito habitat, prior isolations, human population densities, timing of current isolations of virus in mosquitoes, and the cyclical nature of human EEE outbreaks, current weather and seasonal conditions needed to present risk of human disease.

2	Low	Prior Year EEE activity in mosquitoes in the prior year in the focal area Or Current Year 1. Sporadic EEE isolations in *Cs. melanura* mosquito in the community or focal area after July 1 And 2. No animal or human cases. Definitions: ***Sporadic*** EEE activity- when 1-2 mosquito isolates are detected during non-consecutive weeks within one focal area. ***Sustained*** EEE activity- when mosquito isolates are detected for 2 or more consecutive weeks within one focal area.	Response as in category 1, plus: 1. Expand community outreach and public education programs, particularly among high-risk populations, focused on risk potential and personal protection, emphasizing source reduction. 2. Increase larval control and source reduction measures. 3. Locally established standard adult mosquito control activities continue 4. Public health alert sent out by MDPH in response to first EEE mosquito isolate detected during the season. The alert will summarize current surveillance information and emphasize personal prevention strategies.
3	Moderate	Prior Year Confirmation of one human EEE case in the community or focal area; or 1 or more EEE horse, mammal or ratite case(s); or sustained EEE activity in mosquitoes. Or Current year 1. No animal or human EEE cases in current year And 2. Sustained EEEV activity in Cs. melanura after July 1 with minimum infection rates that are at or below mean levels for focal area trap sites. Or 3. Sustained EEEV activity plus at least one multiple meteorological or ecological condition (rainfall, temperature, seasonal conditions, or larval abundance) associated with elevated mosquito abundance and thus likely to increase the risk of human disease Or 4. A single EEEV isolate from mosquitoes likely to bite humans (bridge vector species) Or 5. A single EEEV isolate in mosquitoes of any species, prior to July 1.	Response as in category 2, plus: 1. Outreach and public health educational efforts are intensified including media alerts as needed. 2. If not already in progress, standard, locally established adult mosquito control efforts including targeted ground adulticiding operations should be considered. The decision to use ground-based adult mosquito control will depend on critical modifying variables including the time of year, mosquito population abundance and proximity of virus activity to at-risk populations. 3. Duly authorized local officials may request that the DPH Commissioner issue a certification that pesticide application is necessary to protect public health in order to preempt homeowner private property no-spray requests. 4. Supplemental mosquito trapping and testing in areas with positive EEEV findings. Notify all boards of health of positive findings. 5. Public health alert sent out by MDPH in response to first pool of EEE positive mammal-biting mosquitoes detected during the season. The alert will summarize current surveillance information and emphasize personal prevention strategies. 6. HHAN (Health and Homeland Alert Network) alerts or phone calls are provided to local boards of health upon confirmation of EEE in any specimen; advise health care facilities of increased risk status and corresponding needs to send specimens to SLI for testing.

4	High	Current Year 1, Sustained or increasing EEEV activity in Cs. melanura with weekly mosquito minimum infection rates above the mean. Or 2. Sustained or increasing EEE activity in mosquitoes plus multiple meteorological or ecological conditions (rainfall, temperature, seasonal conditions, or larval abundance) associated with elevated mosquito abundance and thus very likely to increase the risk of human disease. And/or 3..Isolation of EEEV in more than 1 pool of bridge vector mosquitoes And/or 4. Confirmation of EEE in an animal at any time And/or 5. Confirmation of EEE in a human at any time	Response as in category 3, plus: 1. Intensify public education on personal protection measures including avoiding outdoor activity during peak mosquito hours, wearing appropriate clothing, using repellents and source reduction. a. Utilize multimedia messages including public health alerts from MDPH, press releases from local boards of health, local newspaper articles, cable channel interviews, etc. b. Encourage local boards of health to actively seek out high-risk populations in their communities (nursing homes, schools, workers employed in outdoor occupations, etc.) and educate them on personal protection d. Advisory information on pesticides provided by MDPH Bureau of Environmental Health. e. Urge towns and schools to consider rescheduling outdoor events. 2. Intensify larviciding and/or adulticiding control measures where surveillance indicates human risk. Local, ground- based ULV applications of adulticide may be repeated as necessary to achieve adequate mosquito control. Town or city may request preemption of homeowner private property no-spray requests. 3. Active surveillance for human cases is intensified. Health care facilities are advised of increased risk status and corresponding needs to send specimens to SLI for testing. 4. Local officials should evaluate all quantitative indicators including population density and time of year and may proceed with focal area aerial adulticiding. 5. Duly authorized local officials may request that the DPH Commissioner issue a certification that pesticide application is necessary to protect public health in order to preempt homeowner private property no-spray requests. 6. MDPH will confer with local health officials, SRMCB and Mosquito Control Projects to determine if the risk of disease transmission threatens to cause multiple human cases and warrants classification as level 5.

5	Critical	<u>Current Year</u> 1. More than 1 confirmed human EEE case Or 2. Multiple EEE animal cases Or 3. Multiple quantitative measures indicating critical risk of human infection (e.g. early season positive surveillance indicators, and sustained high mosquito infection rates, and horse or mammal case indicating escalating epizootic activity)	Response as in category 4, plus: 1. Continued highly intensified public outreach messages on personal protective measures. Frequent media updates and intensified community level education an outreach efforts. 2. The MDPH Arbovirus Program will determine human risk levels as outlined in this plan. If risk of outbreak is widespread and covers multiple jurisdictions, MDPH will confer with local health agencies, SRMCB and Mosquito Control Projects to discuss the use of intensive mosquito control methods and determine the measures needed to be taken by the agencies to allow for and assure that the most appropriate mosquito control interventions are applied to reduce risk of human infection. These interventions may include state-funded aerial application of mosquito adulticide. Factors to be considered in making this decision include the cyclical, seasonal and biological conditions needed to present a continuing high risk of EEE human disease. Once critical human risk has been identified, the SRMCB will determine the adulticide activities that should be implemented in response to identified risk by making recommendations on: A. Appropriate pesticide B. Extent, route and means of treatment C. Targeted treatment areas 3. Bureau of Environmental Health will initiate active surveillance via emergency departments and with health care provides only if aerial spraying commences. 4. MDPH will designate high-risk areas where individual no spray requests may be preempted by local and state officials based on this risk level. If this becomes necessary, notification will be given to the public. 5. MDPH recommends restriction of group outdoor activities, during peak mosquito activity hours, in areas of intensive virus activity. 6. MDPH will communicate with health care providers in the affected area regarding surveillance findings and encourage prompt sample submission from all clinically suspect cases.

Appendix 1: Mosquitoes Associated with Arboviral Activity in Massachusetts

Aedes vexans – Is a common nuisance mosquito. Temporary flooded areas such as woodland pools and natural depressions are the preferred larval habitat of this mosquito. It feeds on mammals and is a fierce human biter. This species is typically collected from May to October. *Ae vexans* is an epizootic vector of eastern equine encephalitis (EEE) Virus.

Coquillettidia perturbans - Cattail marshes are the primary larval habitat of this mosquito. It feeds on both birds and mammals. It is a persistent human biter and one of the most common mosquitoes in Massachusetts. This species is typically collected from June to September. *Cq perturbans* is an epizootic vector of EEE.

Culex pipiens – Artificial containers are the preferred larval habitat of this mosquito. It feeds mainly on birds and occasionally on mammals. It will bite humans, typically from dusk into the evening. This species is regularly collected from May to October but can be found year round as it readily overwinters in man-made structures. *Cx pipiens* has been implicated as a vector of West Nile Virus (WNV).

Culex restuans – Natural and artificial containers are the preferred larval habitat of this mosquito. It feeds almost primarily on birds but has been known to bite humans on occasion. This species is typically collected from May to October but can be found year round as it readily overwinters in man-made structures. *Cx restuans* has been implicated as a vector of WNV.

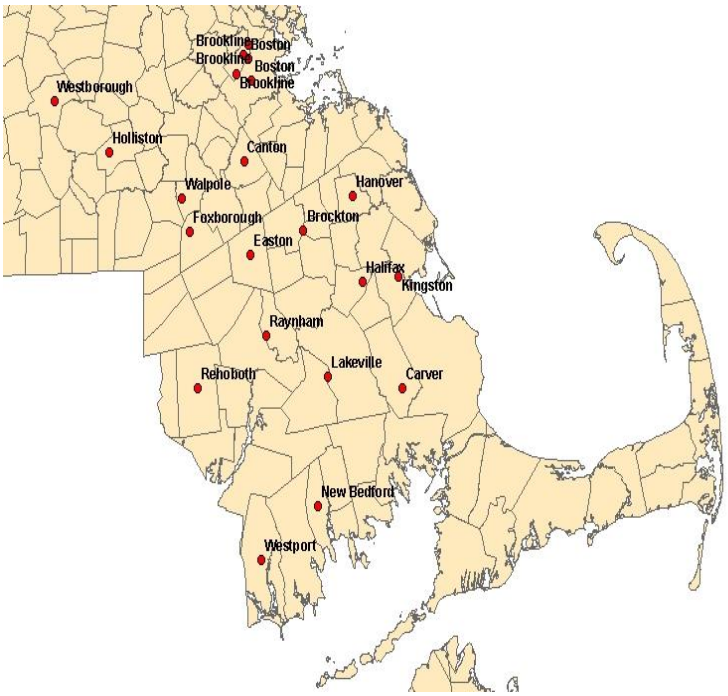
Culex salinarius – Brackish and freshwater wetlands are the preferred habitat of this mosquito. It feeds on birds, mammals, and amphibians and is well known for biting humans. This species is typically collected from May to October but can be found year round as it readily overwinters in natural and man-made structures. *Cx salinarius* may be involved in the transmission of both WNV and EEE.

Culiseta melanura –White cedar and red maple swamps are the preferred larval habitat of this mosquito. It feeds almost exclusively on birds. This species is typically collected from May to October. *Cs melanura* is the primary enzootic vector of EEE.

Ochlerotatus canadensis – Shaded woodland pools are the preferred larval habitat of this mosquito. It feeds mainly on birds and mammals but is also known to take blood meals from amphibians and reptiles. This mosquito can be a fierce human biter near its larval habitat. This species is typically collected from May to October. *Oc canadensis* is an epizootic vector of EEE.

Ochlerotatus japonicus – Natural and artificial containers such as tires, catch basins, and rock pools are the preferred larval habitat of this mosquito. It feeds mainly on mammals and is a fierce human biter. This species is typically collected from May to October. *Oc japonicus* may be involved in the transmission of both WNV and EEE.

Figure 1: Location of MDPH EEE Mosquito Trap Sites



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